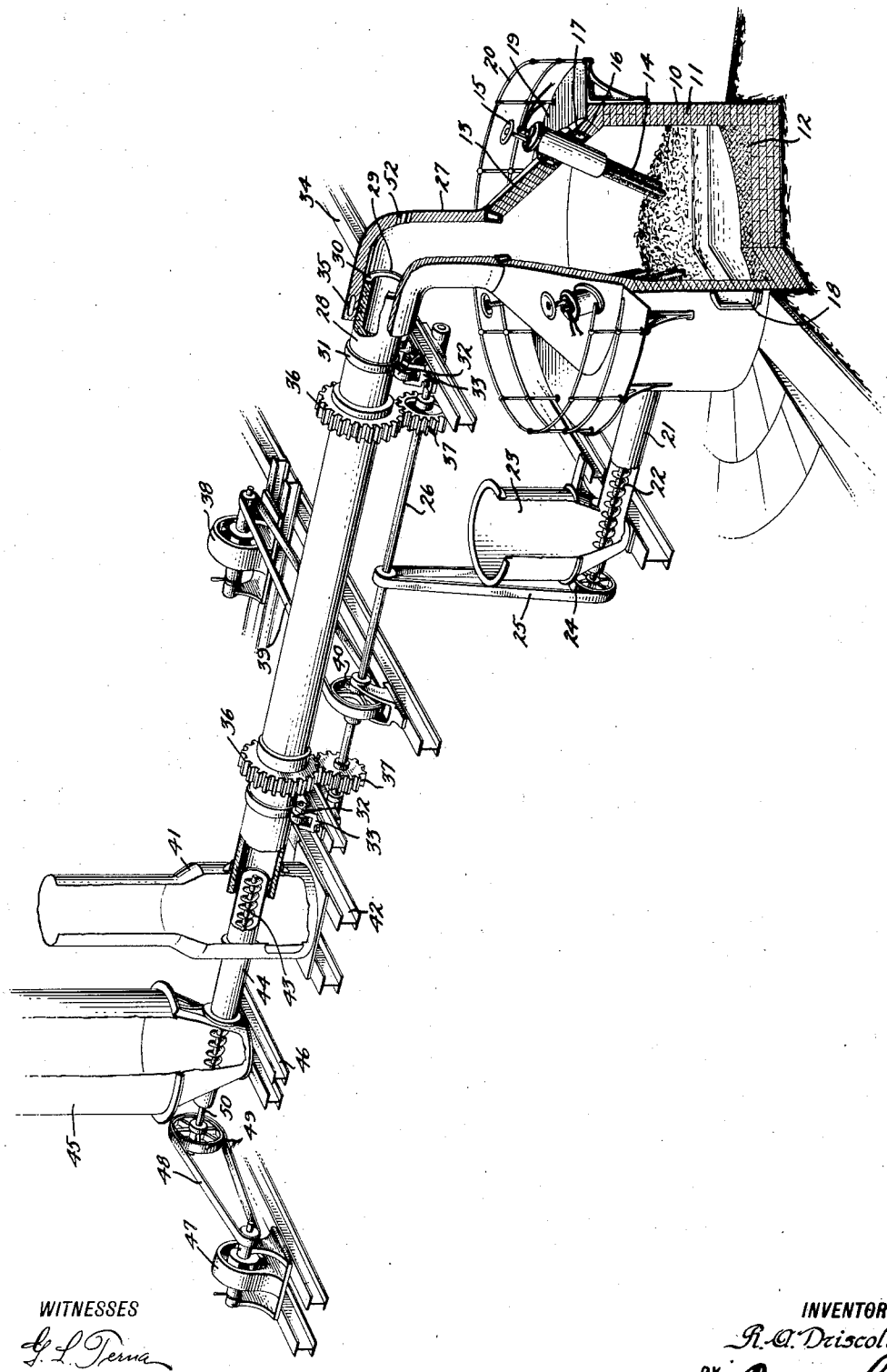
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ELECTRIC FURNACE.

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1,421,185. Patented June 27, 1922.



WITNESSES

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ELECTRIC FURNACE.

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To all whom it may concern:

Be it known that I, ROY A. DRISCOLL, a citizen of the United States, and a resident of Great Falls, county of Cascade, State of Montana, have invented a new and Improved Electric Furnace, of which the following is a full, clear, and exact description.

This invention relates to electric furnaces, and has reference more particularly to an electric furnace in which the ore, slagging materials, and fuel is charged into the furnace by means of a rotary tube through which the waste gases from the furnace pass.

An object of this invention is to provide an electric furnace combining the advantages inherent in ordinary electric furnaces with the advantages common to blast furnaces of providing a heated chamber through which the ore—slagging materials—fuel mixture passes before entering said furnace, where a partial reduction of the ore takes place.

Another object of this invention is to provide an electric furnace in which very low grade fuel such as slack, oil residue, etc., may be utilized.

A further object of this invention is to provide a highly efficient electric furnace which will be charged automatically, so that labor costs are greatly reduced.

A still further object of this invention is to provide an electric furnace in which a charge is thoroughly mixed, preheated, and partially reduced by the waste gases issuing from the furnace before said charge enters said furnace.

A still further object of the invention is to provide an electric furnace in which all the operations are continuous so that a uniform product is obtained.

It is a well known fact that the blast furnace is a very efficient means for the reduction of iron from its ore, and in order to compete therewith, the electric furnace for a similar purpose must be operated near a point where cheap electric power is available. Generally speaking, the electric furnace cannot be operated where the electric power available has to be generated by coal owing to the high price of said coal. In large areas of the western part of the United States, and in other sections of the world, enormous quantities of water power are available in a region where iron ore and cheap carbon in the form of low grade coal is also plentiful. In these regions often the coal is not of the type suitable for the manufacture of coke, so that the operation of a blast furnace is a commercial impossibility, since it depends upon the use of a high quality coke or anthracite coal. In these regions an electric furnace which can utilize the large amount of water power available, and can also utilize the low grade fuel, will be a valuable means of smelting the ore found in the region.

Reference is to be had to the accompanying drawing forming a part of this specification in which it is understood that the drawing is merely illustrative of one example of my electric furnace, which is adapted to meet the above requirements, and in which the figure is a perspective view of my improved electric furnace, showing parts broken away to disclose the interior construction.

Referring to the accompanying drawing by numerals, 10 indicates the outside shell forming the walls of an electric furnace which is lined with any refractory material 11, and is provided with a hearth 12 composed of any suitable material which may be acid, neutral, or basic. The said furnace is constructed with a roof 13, preferably frusto-conical in shape, said roof being also lined with refractory material such as fire brick. A plurality of electrodes 14, preferably three in number, extend through the roof 13 into the interior of the electric furnace. These electrodes may be formed from sticks of carbon and may be adjustable axially by means of control wheels 15, so that said electrodes may be in contact with the charge to form a resistance furnace or may be withdrawn somewhat from the charge so that the furnace is operated as a combination resistance and arc furnace. The furnace may also be operated as an arc, induction or a combination of any of the aforementioned types of furnaces. Furthermore, I do not wish to limit myself to any particular type of electric furnace or electric current supplied thereto, since a direct current or an alternating current operating on a single, double, or poly-phase circuit may be used.

The electrodes 14 may be supported in the roof 13 of the furnace by means of castings 16 having passage 17 through which a liquid may be circulated to prevent said castings from melting. The electric furnace is also provided with a transparent door 18 through

which the condition and quality of the charge may be observed. Around the top of the furnace a platform 19 may be fixed, guarded by a rail 20 so that a workman may operate the control wheels 15. Extending through the wall 10 of the furnace, I provide a tube 21 in which is rotatably and co-axially mounted a screw conveyor 22, said conveyor passing through the bottom of a storage tank 23, which may preferably contain a powdered fuel so that said fuel may be supplied to the furnace as said screw conveyor is rotated by any power means such as a pulley 24 fixed to said screw conveyor and operatively connected by means of a belt 25 to a power shaft 26. The roof 13 in the furnace terminates in an opening, and is connected to a pipe 27 which is bent at right angles so as to rotatably telescope around a rotary reduction furnace 28.

This rotary reduction furnace consists of an outer shell 29 lined with some refractory material 30, and is rotatably mounted by means of a plurality of encircling bearing rings 31 fixed to the outside periphery of the shell 29, said rings resting on supporting rollers 32. The rollers 32 may be journaled in any suitable bearing 33, which rest on a frame work 34. The pipe 27 may be water cooled at its junction with the furnace 28 by passing a cooling liquid through the chambers 35. The rotary furnace 28 may be rotated by means of spur gears 36 which are fixed to the outside periphery of the shell 29 and engage similar spur gears 37 which are fixed to the power shaft 26. The power shaft 26 may be rotated by a suitable source of power such as an electric motor 38 connected by a belt 39 to a pulley 40 which is fixed to the shaft 26. The rotary furnace 28 has its axis preferably inclined at a slight angle with the horizontal so that material feeds in at its upper end, and gradually works down as the furnace is rotated and drops into the electric furnace. The upper end of the rotary furnace 28 terminates in a stack 41, which rests on suitable supporting beams 42. The stack 41 serves to carry away the waste gases issuing from the furnace 28.

The rotary furnace 28 and the electric furnace are charged with ore, slagging materials, and fuel by means of a screw conveyor 43, co-axially mounted in a tube 44, said tube passing through the bottom of the stack 41 and telescoping inside the upper end of the furnace 28. The screw conveyor 43 passes through the bottom of a storage tank 45 which is charged with a mixture of materials by some suitable means not shown, and rests on suitable supporting beams 46. The screw conveyor 43 may be rotated by any power means such as a motor 47 connected by a belt 48 to a pulley 49 fixed to the conveyor shaft 50 of the conveyor 43. Compressed air is supplied to the furnace through an air duct 51 which is connected with tuyeres 52 formed in the pipe 27.

In operation, the rotary furnace 28 and screw conveyor 43 are continuously rotated so that a steady stream of charging material drops into the electric furnace from the lower end of the rotary furnace 28 through the pipe 27. An auxiliary supply of fuel is admitted to the electric furnace somewhat above the top of the charge by means of the screw conveyor 22. This fuel containing carbon drops on the hot charge in the furnace and assists in reducing the iron ore to iron. The fuel admitted by means of the screw conveyor 22 gives off a large volume of gas when it drops on the top of the hot charge of the electric furnace and this gas passes upwardly into the pipe 27 where it meets a supply of air admitted through the air duct 51 and the tuyeres 52. At this point a partial combustion of the gas takes place, the completeness of said combustion being regulated by the quantity of the air supplied through the air duct 51, so that the hottest zone in the reducing furnace is located at its lower end, and the temperature gradually diminishes as the upper end is reached. The carbon contained in the charging mixture passing through the furnace 28 is heated to a high temperature by the hot gases from the electric furnace, so that the carbon contained in said fuel partly reduces the ore contained in the charging mixture. If a quantity of air insufficient for complete combustion is admitted to the air duct 51, carbon monoxide is formed, which also acts as a reducing agent in bringing the reduction of the iron ore nearer completion at the lower and the hotter end of the furnace 28, before said charging mixture drops into the electric furnace. The hot gases passing through the rotary furnace 28 also serve to decompose the lime stone usually contained in the charging mixture to form calcium oxide and carbon dioxide. The gases are greatly cooled as they travel up the furnace 28 until when near the upper end where they serve only to dry the charging mixture and drive off any moisture or light, volatile matter.

Thus it is seen that most of the chemical reactions which ordinarily occur in an electric furnace of the common type, are carried on by the waste gases from the furnace before the charging mixture reaches the electric furnace, so that the quantity of power ordinarily needed to carry out these reactions is greatly diminished, and as a result about half the electrical energy is needed for each ton of iron smelted from its ore.

While my improved electric furnace is specially adapted for the smelting of iron from its ore, it may also be modified or adapted for the making of any alloy such as ferro-chrome, cupro-vanadium, cupro-manganese, ferro-vanadium, ferro-molybdenum,

silico-chrome, ferro-titanium, and also calcium carbide.

My improved electric furnace has many advantages over the blast furnaces ordinarily used in the smelting of ores, and also over other electric furnaces in common use.

The fundamental advantage of the improved furnace is the fact that the preliminary reduction by the waste gases in the rotary furnace carry out chemical reactions which would otherwise have to be carried out at the expense of electrical energy, so that as a result the furnace has a capacity per K. W. hour which is double that of the ordinary electric reduction furnace. Furthermore, a higher voltage may be used and the waste gases going up the stack have a very low temperature so that the heat lost in the process is reduced to a minimum. The reducing conditions obtained in the stack of an ordinary blast furnace where the ore is partly reduced before reaching the hot zone, is exactly reproduced in my improved furnace on a still higher efficiency, as the charging material is continuously stirred by the rotary furnace while being subjected to the reducing gases passing therethrough.

In the use of an ordinary blast furnace it is absolutely essential to use a high grade metallurgical coke or anthracite coal, both of which are very expensive, so that the charge will be porous enough for the uniform distribution of the incoming blast of air. In my improved electric furnace any type of low grade fuel may be used such as slack coal, oil residue, etc. In many parts of the country large quantities of finely powdered coal and slack are thrown away because of the lack of uses for the same. My improved furnace can be used in districts containing available water power, and only a poor quality fuel unsuited for the production of coke, where it would be commercially impossible to operate a blast furnace for the smelting of the iron ore when the coke essential for its operation would have to be shipped from a distance. It is commonly known that the initial cost of installing an electric furnace and the cost for repairs is much smaller than for a blast furnace for a given output, and my improved furnace embodies all of these qualities inherent in ordinary electric furnaces. This saving in the cost of installation is specially noticed owing to the fact that a much smaller quantity of air is necessary in the operation and therefore a much smaller unit of blowing engines is necessary.

Many of the electric furnaces in use at present operate intermittently, and as a result a uniform product cannot be obtained. It is commonly known that in industrial processes, a continuous operation is essential to the output of a product of uniform and high quality, and my improved furnace meets these requirements.

An ordinary electric furnace is subject to shut-downs because of inefficient operation, owing to the fact that scaffolds and hang-ups called "monkeys" are formed by various compounds which consist of calcium carbide, graphite, carborundum, etc., which impede the working of the furnace, fill up the hearth, break up the path of the electric current, and cut down the output of the furnace until it is eventually necessary to shut it down. In the improved furnace these conditions cannot occur and the loss of time due to shut-downs will be reduced to a minimum.

Another distinctive feature of this electric furnace, is that more carbon may be used than is necessary to just reduce the ore, since an excess of carbon will not injure the furnace as it does the ordinary electric reduction furnace. Furthermore the burdening of the furnace does not have to be so scientifically exact as in the ordinary electric reduction furnace, thus making it easier to operate said furnace and obtain results. In the improved furnace the composition of the charge is easily controlled and a high silicon, high carbon, pig iron, or a low silicon, low carbon iron can be made which may be quickly converted into steel in an electric steel furnace at an expenditure of 200 to 300 K. W. hours per ton. In operation the furnace is very flexible since the quantity of air and proportions of charge entering the furnace may be varied at the operator's option, so that the furnace is easily adaptable for the making of alloys of all descriptions, and the condition of the charge during the operation may be easily observed through the transparent door. Since my improved furnace is charged automatically, the cost of labor in operating the furnace is greatly reduced over that of the ordinary electrical furnace or the blast furnace.

It has been found that under certain conditions in a blast furnace the nitrogen in the air produces nitrides of iron, which have a bad effect on iron and steel since it renders them brittle. Consequently the elimination of nitrogen in the electric furnace not only prevents inefficiency but also allows certain grades of ore to be handled which would not submit to the usual treatment by the blast furnace. This is particularly important where magnetites occur which contain too much sulfur for blast furnace treatment, but can be economically smelted by use of the electric current.

I would state in conclusion that while the illustrated example constitutes a practical embodiment of my invention, I do not

limit myself strictly to the mechanical details herein illustrated, since manifestly the same can be considerably varied without departure from the spirit of the invention as defined in the appended claims.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:

1. The combination with an electric furnace of a gas outlet in the roof of said furnace, means for injecting air into said outlet, a rotatably mounted tube connected to said outlet, said tube being positioned with its axis at an angle to the horizontal, a screw conveyor rotatably mounted in the upper end of said tube, a container associated with said screw conveyor, means for rotating said screw conveyor so as to transfer charging material from said container to the upper end of said tube, and means for rotating said tube so that said charging material will be delivered to said electric furnace.

2. The combination with an electric furnace of a gas outlet in the roof of said furnace, means for injecting air into said outlet, a rotatably mounted tube connected to said outlet, said tube being positioned with its axis at an angle to the horizontal, means for supplying charging material to the upper end of said tube, means for rotating said tube so that the charging material will be delivered to said electric furnace, a container, and a screw conveyor adapted to remove other charging from said container and deliver it to said electric furnace.

3. The combination with an electric furnace of a gas outlet in the roof of said furnace, means for injecting air into said outlet, a rotatably mounted tube connected to said outlet, said tube being positioned with its axis at an angle to the horizontal, a rotatably mounted screw conveyor, a container associated with said screw conveyor, means for rotating said screw conveyor so as to transfer charging material from said container to the upper end of said tube, means for rotating said tube so that said charging material will be delivered to said electric furnace, an auxiliary container, and a screw conveyor adapted to remove other charging material from the auxiliary container and deliver it to said electric furnace.

4. The combination with an electric furnace of a rotatably mounted tube positioned with its axis inclined at an angle to the horizontal, the lower end of said tube being connected to an opening in said furnace, means for rotating said tube, and auxiliary means for continuously injecting charging materials into said electric furnace.

5. The combination with an electric furnace of a gas outlet in the roof of said furnace, means for injecting air into said outlet, a rotatably mounted tube connected with said outlet, said tube being positioned with its axis at an angle to the horizontal, means for rotating said tube, means for introducing charging materials into the upper end of said tube, and auxiliary means for introducing charging materials into said furnace.

6. The combination with an electric furnace of a gas outlet in the roof of said furnace, means for continuously injecting air into said outlet, a rotatably mounted tube connected with said outlet, said tube being positioned with its axis at an angle to the horizontal, means for rotating said tube, means for continuously introducing charging materials into the upper end of said tube, and auxiliary means for continuously introducing charging materials into said furnace.

ROY A. DRISCOLL.